Poxviruses and Australian wild birds

Fact Sheet

April 2024

Key points

- Avian poxviruses represent a large and diverse group of viruses, which infect most bird species throughout the world.
- Poxviruses appear to have been present in bird populations for centuries, leading to low levels of infection and relatively mild disease.
- The cutaneous form of poxvirus infection causes dry scabs on featherless areas such as the feet, eyelids or mouth, which generally self-resolve. Infection is highly contagious through insect vectors or contact of broken skin with scabs and contaminated perches.
- If poxviruses are introduced to naïve bird populations, they have the potential to cause explosive outbreaks of severe systemic disease with high morbidity and mortality, such as has occurred in Hawaii, the Galapagos and the Canary Islands.
- Prevalence is related to prolonged persistence on perches and in scabs, vector abundance, host density and susceptibility, and the movement of infected animals. Control of these factors are key to management of affected birds and populations.

Aetiology

Avian pox is caused by viruses of the genus *Avipoxvirus* in the family *Poxviridae*, subfamily *Chordopoxvirinae*. Poxviruses are large double stranded enveloped DNA viruses. There are 12 recognised species: fowlpox, turkeypox, canarypox, pigeonpox, quailpox, sparrowpox, starlingpox, juncopox, psittacinepox, peacockpox, penguinpox and mynah pox. It is likely that this list will increase further as unclassified poxviruses are characterised [1]. Most poxviruses infect a variety of host species and it is unclear to what extent the host spectrum is affected by anthropogenic factors [2, 3].

One Health implications

Wildlife and the environment: endemic poxviruses usually cause mild and self-limiting lesions, however affected wild birds may have an increased risk of mortality or reduced reproductive success due to tissue damage or secondary infections [4, 5]. Where poxviruses have been introduced to naïve bird populations, they have the potential to cause explosive outbreaks of severe disease with high morbidity and mortality [3, 5]. Poxviruses may be a risk factor for reintroduction and translocation of wild birds [5-8].

Domestic animals: avian poxviruses may impact a broad range of bird species within the poultry, zoo and avicultural industries. Mortality is usually low in affected flocks but can be widespread [9].

Reduced weight gain and egg production, blindness, and mortalities may impact productivity [5, 9, 10]. Infection and disease in mammals has not been described [11].

Humans: there is no evidence that avian poxviruses are zoonotic [1, 2].

Natural hosts

It seems likely that all bird species are susceptible to avian poxvirus infection. Avian pox has been recorded from 374 bird species from 70 families and 23 orders [1, 3]. Certain groups of poxviruses favour specific avian families or orders, however even these host-adapted avian poxviruses can cause cross-species infection within predator-prey systems [5].

World distribution and occurrences in Australia

Poxviruses have a worldwide distribution and are likely widespread throughout the Australian birds. Australian native species reported with poxvirus infection are shown in Appendix 1. A survey of 486 hospitalised wild birds in south-east Qld reported a general avian poxvirus prevalence of almost 10% using PCR, with infection rates being highly variable between species (0-82.35%) [12].

Psittacinepox is considered exotic to Australia [13] but there are reports of two cases of pox in crimson rosellas (*Platycercus elegans*) [14]. The relationship of the crimson rosella virus to the poxvirus syndrome associated with psittacinepox infection of South American parrots and parakeets (*Amazona* spp. and *Ara* spp.), which causes profound clinical disease, morbidity and death in these species, is not known.

Epidemiology

Poxviruses are most commonly transmitted mechanically by biting invertebrates such as mosquitoes, mites, midges or flies [15, 16]. In temperate regions, where vectors are not active during the winter, infections occur primarily in the summer and early autumn. In warmer areas avian pox can occur throughout the entire year but is most common during autumn and winter because host densities are highest due to large numbers of susceptible chicks.

Transmission can also occur directly by contact between infected and susceptible birds or by contact with contaminated objects such as bird feeder perches. Poxviruses are extremely resistant, being able to survive on perches and in dried scabs for months to years. Poxviruses are unable to penetrate intact skin and need to gain entry through wounds.

Aerosol transmission by inhalation of dust contaminated with virus is possible, although rare, and results in lesions in the alimentary tract and lungs, or systemic infection [17].

Incubation period is seven to nine days for pigeons and from four days to three weeks for canaries [18].

Avian poxvirus has been detected in all major avian orders, with a reported incidence of 0.5-1.5% in continental regions, however the occurrence of lesions is highly variable [3]. In more naïve populations prevalence can be as high as 50% [17]. While endemic poxvirus does not appear to pose a threat to established populations of free-ranging bird species, increasing global temperatures could potentially result in increased vector numbers and longer periods of vector activity, possibly resulting in increasing incidence and prevalence of poxvirus infections.

Much is still unknown about the host spectrum of many of the poxviruses e.g. magpie poxvirus disease was experimentally transmitted to other magpies but not to chickens, turkeys, pigeons or canaries. Experimentally transmitted fowlpox virus caused disease in chickens and turkeys but not pigeons [19].

Birds that have recovered from pox infections are usually immune to reinfection with that strain for six to twelve months [17, 20].

Clinical signs

Cutaneous lesions are most commonly found on featherless areas of the skin, usually on the feet and legs, or on the eyelids and base of the beak. They usually present as large wart-like nodules and may be big enough to impair function. Ulceration, haemorrhage and necrosis of the lesions may lead to myiasis and secondary bacterial infections. Facial lesions may extend into the oral cavity and involve the tongue and palate, while lesions on the feet can disrupt circulation to the extremities and result in loss of digits [21]. Systemic infections may cause inflammation of multiple organs and present with respiratory distress or sudden death [22, 23].

Diagnosis

A presumptive diagnosis is based on clinical signs, and should be confirmed with histopathology. Histological demonstration of intracytoplasmic inclusion bodies in hypertrophic epithelial cells is considered pathognomonic for poxvirus infection [18]. This can be substantiated by PCR, viral isolation or using electron microscopy to demonstrate typical poxvirus particles, and strains identified using molecular sequencing or serological assays (virus neutralization, ELISA, immunodiffusion on agar gel and hemagglutination- inhibition) [2, 3, 17].

Laboratory diagnostic specimens and procedures

Diagnostic specimens include crusted lesions, and swabs or biopsies of skin or mucosal lesions. Tissues may be placed in buffered formalin for histopathology, or submitted fresh, frozen or in viral transport medium for PCR or viral isolation. Lung or brain tissue should be submitted for mortalities with systemic or neurologic abnormalities respectively.

Pathology

Grossly, cutaneous pox lesions appear as firm nodules with a homogenous consistency on cut surface. Infections cause localized proliferations of epithelial cells. Affected cells become hyperplastic and hypertrophic. Hypertrophy and large granular acidophilic intracytoplasmic inclusions (Bollinger bodies) appear as the cells mature. These inclusion bodies contain typical dumbbell shaped pox particles [17, 21]. Systemic pox is characterised by widespread histiocytic inflammation of visceral tissues with intra-histiocytic viral inclusions [23].

Differential diagnoses

Differential diagnoses include those diseases that can cause proliferative lesions on the head and legs, such as *Knemidocoptes* sp. infection and papilloma virus [2, 24], and those that cause lesions in the oral cavity such as candidiasis, capillariasis, mycotoxicosis and trichomoniasis [17].

Treatment, prevention and control

Poxvirus infections are generally self-limiting with uncomplicated lesions healing in three to four weeks. Secondarily infected lesions can be treated with topical antimicrobials. Systemic antibiotics and supportive treatment may aid recovery [18].

Control of the disease in wild bird populations is difficult and should focus on reducing vectors, such as mosquitoes. Captive birds can be held in screened insect-proof enclosures. Any diseased birds should be isolated and held in separate screened enclosures to prevent the disease spreading. Perches, feeders and birdbaths should be cleaned regularly with a disinfectant [17]. Disinfectants that can inactivate poxviruses include 5-10% bleach, 1% potassium hydroxide, 2% sodium hydroxide, 5% phenol, 5-10% bleach, or heating to 50°C for 30 minutes or 60°C for eight minutes [11, 17].

Commercial vaccines have been developed for fowlpox, canarypox and falconpox, however there are significant barriers to their use in wild birds [25, 26]. A fowlpox vaccine was found to be safe and effective in zebra finches (*Taeniopygia guttata*), and a pigeonpox vaccine has been tested in falcons, however cross-reactivity is highly dependent on strain [27-30]. The effectiveness of using commercial avian pox vaccines to reduce mortality of wild birds during epidemics is unknown [27, 28]. Critical assessment of safety, potential for vaccine reactions, extent of cross-protection, duration of immunity, diversity of field strains, and efficacy after a single dose would be essential prior to use in free ranging or vulnerable species [27].

Stress associated with translocation may play a role in poxvirus outbreaks so appropriate risk assessment and mitigation should be considered [30]. Ongoing surveillance will be necessary to prevent or mitigate impacts on wild bird populations.

Research

Avian poxvirus infection in Australian birds is far more common than the figures in the National Wildlife Health Surveillance Database suggest and little is known about the poxviruses that have been reported. The majority have not been characterised and there is almost no information on species specificity or transmission.

It also seems likely that previously unrecognised poxvirus strains exist in Australia, such as the one identified in crimson rosellas [14]. Poxvirus seems to occur particularly frequently in magpies (and magpie larks) but it has not been determined if this is a new viral species or an already recognised species that has spilled over into magpie hosts.

More information is required on the cross protection of poxvirus vaccines.

Surveillance

Australia's general wildlife health surveillance system logs cases of poxviruses in wild birds in the national database.

Wildlife Health Australia administers Australia's general wildlife health surveillance system, in partnership with government and non-government agencies. Wildlife health data is collected into a national database, the electronic Wildlife Health Information System (eWHIS). Information is reported by a variety of sources including government agencies, zoo based wildlife hospitals, sentinel veterinary clinics, universities, wildlife rehabilitators, and a range of other organisations and individuals. Targeted surveillance data is also collected by WHA. See the WHA website for more information https://wildlifehealthaustralia.com.au/Our-Work/Surveillance and https://wildlifehealthaustralia.com.au/Our-Work/Surveillance/eWHIS-Wildlife-Health-Information-System.

We encourage those with veterinary or laboratory confirmed cases of this condition in native Australian or feral animals to submit this information to the national system for consideration for inclusion in the national database. Please contact us at admin@wildlifehealthaustralia.com.au.

Appendix 1

Table 1. Species identified with avian poxvirus infection among free-ranging wild birds in Australia

Species	Reference
Australian kestrel (*Falco cenchroides*)	eWHIS
Australian king-parrot (*Alisterus scapularis*)	Kasimov et al. 2023 [12]
Australian magpie (*Gymnorhina tibicen*)	Harrigan et al. 1975 [19], Annuar et al. 1983 [31], Chung and Spradbrow 1977 [32], Reece and Hartley 1994 [33]
Barn owl (*Tyto alba*)	Kasimov et al. 2023 [12]
Bar-shouldered Dove (*Geopelia humeralis*)	Kasimov et al. 2023 [12]
Black kite (*Milvus migrans*)	eWHIS
Black swan (*Cygnus atratus*)	Bolte et al. 1999 [17]
Black-faced cuckoo shrike (*Coracina novaehollandiae*)	Reece and Hartley 1994 [33], Sutton and Filippich 1983 [34]
Blue-faced honeyeater (*Entomyzon cyanotis*)	eWHIS
Brown falcon (*Falco berigora*)	Ladds 2009 [35]
Brown noddy (*Anous stolidus*)	Bolte et al. 1999 [17]
Butcher bird (Family *Artamidae*; *Cracticus* spp.)	Reece and Hartley 1994 [33], eWHIS
Cape Barren goose (*Cereopsis novaehollandiae*)	Reece and Hartley 1994 [33]
Collared sparrowhawk (*Accipiter cirrhocephalus*)	eWHIS
Common noddy (*Anous stolidus*)	Ladds 2009 [35]
Cook's petrel (*Pterodroma cookii*)	eWHIS
Corella (*Cacatua* spp.)	Kasimov et al. 2023 [12]
Crested pigeon (*Ocyphaps lophotes*)	Kasimov et al. 2023 [12]
Crimson rosella (*Platycercus elegans*)	eWHIS
Crow and raven (*Corvus* spp.)	Harrigan et al. 1975 [19], Ladds 2009 [35]
Currawongs (*Strepera* spp.)	eWHIS
Emu (*Dromaius novaehollandiae*)	Blyde 1992 [36]

Species	Reference
Forest kingfisher (*Todiramphus macleayii*)	Kasimov et al. 2023 [12]
Galah (*Eolophus roseicapilla*)	Kasimov et al. 2023 [12]
Indian myna (*Acridotheres tristis*)	eWHIS
Laughing kookaburra (*Dacelo novaeguinea*)	Kasimov et al. 2023 [12]
Lesser noddy (Anous tenuirostris)	Bolte et al. 1999 [17]
Little eagle (*Hieraaetus morphnoides*)	eWHIS
Little penguin (*Eudyptula minor*)	Reece and Hartley 1994 [33]
Magpie-lark (*Grallina cyanoleuca*)	Annuar et al. 1983 [31], Reece and Hartley 1994 [33]
Musk lorikeet (*Glossopsitta concinna*)	eWHIS
Nankeen kestrel (*Falco cenchroides*)	Ladds 2009 [35], Kasimov et al. 2023 [12]
Noisy miner (*Manorina melanocephala*)	eWHIS
Noisy pitta (*Pitta versicolour*)	Reece and Hartley 1994 [33]
Pale-headed rosella (*Platycercus adscitus*)	Kasimov et al. 2023 [12]
Pale-yellow robin (*Tregellasia capito*)	eWHIS
Peregrine falcon (*Falco peregrinus*)	Ladds 2009 [35]
Pied currawong (*Strepera graculina*)	Reece and Hartley 1994 [33]
Rainbow lorikeet (*Trichoglossus moluccanus*)	Kasimov et al. 2023 [12]
Red-tailed tropic bird (*Phaethon rubricauda*)	Reece and Hartley 1994 [33]
Red wattlebird (*Anthochaera carunculate*)	eWHIS
Sacred kingfisher (*Todiramphus sanctus*)	Kasimov et al. 2023 [12]
Shearwaters (*Ardenna* spp.)	eWHIS; Sarker et al. 2017 [37]
Shy albatross (*Thalassarche cauta*)	Woods 2004 [38]
Silvereye (*Zosterops lateralis*)	Annuar et al. 1983 [31]; Reece and Hartley 1994 [33]
Sooty tern (*Onychoprion fuscatus*)	Annuar et al. 1983 [31]
Spinifex pigeon (*Geophaps plumifera*)	Reece and Hartley 1994 [33]
Spotted dove (*Spilopelia chinensis*)	Kasimov et al. 2023 [12]
Sulphur crested cockatoo (*Cacatua galerita*)	Kasimov et al. 2023 [12]
Superb blue fairy wren (*Malurus cyaneus*)	Harrigan et al. 1975 [19]
Tawny frogmouth (*Podargus strigoides*)	Reece and Hartley 1994 [33]
Whistling kite (*Haliastur sphenurus*)	Reece and Hartley 1994 [33]
White-backed magpie (Gymnorhina hypoleuca)	Harrigan et al. 1975 [19]; Phillips 1988 [39]
White-bellied sea eagle (*Haliaeetus leucogaster*)	Kasimov et al. 2023 [12]
White-winged chough (*Corcorax melanorhamphos*)	Ladds 2009 [35]

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